PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-273337

(43)Date of publication of application : 08.10.1999

(51)Int.Cl. G11C 11/15

(21)Application number : 11-026344

(22)Date of filing : 03.02.1999

(71)Applicant : INTERNATL BUSINESS MACH CORP <IBM>

(72)Inventor : ABRAHAM DAVID WILLIAM
GALLAGHER WILLIAM JOSEPH
TROUILLOUD PHILIP LOUIS

(30)Priority

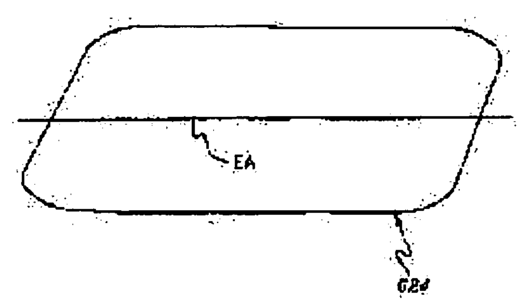
Priority number : 98 21515 Priority date : 10.02.1998 Priority country : US

(54) INTERNAL SYMMETRY IN MAGNETIC RAM CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a magnetic memory which has a 1st and a 2nd crossing conductor forming an intersection area.

SOLUTION: The magnetic memory cell 642 includes a variable magnetic area having a magnetic axis given two magnetization direction along itself, and consequently two kinds of state that the cell can change into according to electricity applied thereto and the resulting magnetic stimulation are provided. In order to enable the predictable development of a magnetic pattern from the 1st direction to the 2nd direction, the asymmetry of the magnetic stimulation applied to the cell while some state is written thereto is disclosed. Further, the layout of the cell or the physical asymmetry of magnetism which



enables the predictable development of the pattern are also disclosed. This principle is applicable to a magnetic random access memory(MRAM) array using a magnetic tunneling

junction cell at the intersection of a bit line and a word line supplying electricity and the resulting magnetic stimulation so as to write the cell therein.

LEGAL STATUS

[Date of request for examination]	09.08.1999
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3548036
[Date of registration]	23.04.2004
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

(19)日本国特許庁（JP）　(12) 公開特許公報（A）　(11)特許出願公開番号

特開平11－273337

(43)公開日 平成11年(1999)10月8日

(51)Int.Cl.⁶	識別記号	FI
G11C 11/15		G11C 11/15

審査請求 未請求 請求項の数35 OL （全 14 頁）

(21)出願番号 特願平11－26344

(22)出願日 平成11年(1999) 2月3日

(31)優先権主張番号 09/021515

(32)優先日 1998年2月10日

(33)優先権主張国 米国（US）

(71)出願人 390009531
インターナショナル・ビジネス・マシーンズ・コーポレイション
INTERNATIONAL BUSINESS MASCHINES CORPORATION
アメリカ合衆国10504、ニューヨーク州アーモンク （番地なし）

(72)発明者 デーヴィッド・ウィリアム・エイブラハム
アメリカ合衆国10562 ニューヨーク州オシニング スノードン・アベニュー 67

(74)代理人 弁理士 坂口 博 （外1名）

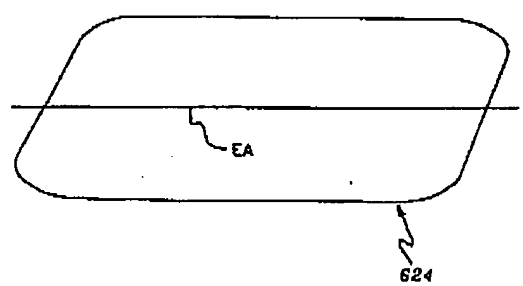
最終頁に続く

(54)【発明の名称】 磁気RAMセル内の内部非対称

(57)【要約】

【課題】 交差領域を形成する第1および第2の交差導線を有する磁気メモリを提供すること。

【解決手段】 磁気メモリ・セルは、それに沿って2通りの磁化方向を課すことができる磁気軸を備えた可変性磁気領域を含み、それにより、それに印加された電気および結果的な磁気刺激に応じてセルが変化可能な2通りのそれぞれの状態を提供する。第1の方向から第2の方向へ予測可能な磁化パターンの発展を可能にするために、ある状態をそこに書き込んでいる間にセルに印加される磁気刺激の非対称を開示する。また、予測可能なパターンの発展を可能にする、セルのレイアウトまたは磁化の物理的非対称も開示する。このような原理は、そこにセルを書き込むために電気および結果的な磁気刺激を供給するビット線とワード線の交点で磁気トンネル接合（MTJ）セルを使用する、磁気ランダム・アクセス・メモリ（MRAM）アレイに適用することができる。



CLAIMS

[Claim(s)]
[Claim 1] It is a magnetic memory cell including the variability MAG field equipped with the 1st and 2nd crossover lead wire which forms a crossover field, and the magnetic shaft which is arranged to said crossover field and can impose two kinds of magnetic directions along with it. By that cause Magnetic memory which offers two kinds from which said cel can change of each condition according to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, and contains the magnetic memory cell by which said variability MAG field is asymmetrically fabricated substantially magnetically around the magnetic shaft.
[Claim 2] Magnetic memory according to claim 1 by which said variability MAG field of said magnetic memory cell equips the corner with the include angle of a non-right angle, and is fabricated as a plane parallelogram substantially [the surroundings of the magnetic shaft].
[Claim 3] Magnetic memory according to claim 1 by which said magnetic memory cell is arranged in said crossover field so that the magnetic shaft may become parallel to one side of said 1st and 2nd crossover lead wire.
[Claim 4] Magnetic memory according to claim 1 by which said variability MAG field is magnetically fabricated asymmetrically by the internal magnetic anisotropy around the magnetic shaft.
[Claim 5] Magnetic memory according to claim 1 which includes further the magnetic-bias field nearest to [in order to bring an unsymmetrical configuration magnetically to the surroundings of said magnetic shaft, applying bias] said variability MAG field.
[Claim 6] It is substantially fabricated as a square which has the magnetic shaft with which alignment of said variability MAG field was carried out among the corners which the 1st square pair counters. Alignment of said bias is carried out along the corner where the 2nd pair of said square counters, and said bias maintains the common magnetization direction in all four corners of said square. By that cause Magnetic memory according to claim 5 on which the magnetic asymmetry of said variability MAG field is brought to the surroundings of said magnetic shaft, and two kinds of magnetization directions are imposed in the internal part of the variability field of said square.
[Claim 7] The 1st and two or more 2nd crossover lead wire which form two or more crossover fields including said crossover field including said 1st and 2nd crossover lead wire, Each is arranged at one each of two or more of said crossover fields including said magnetic memory cell. Magnetic memory according to claim 1 which contains further two or more magnetic memory cells asymmetrically fabricated substantially magnetically around the magnetic shaft with which each can impose two kinds of magnetization directions along with it so that two kinds from which each cel can change of each condition may be offered.
[Claim 8] Two kinds of magnetization directions in alignment with said magnetic shaft are the opposite magnetic memory according to claim 1 mutually.
[Claim 9] Magnetic memory according to claim 1 in which said magnetic memory cell is formed from at least one magnetic tunnel junction.
[Claim 10] The step which prepares the 1st and 2nd crossover lead wire which is an approach for

creating magnetic memory and forms a crossover field by that cause, The variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it is included. By that cause According to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, two kinds from which a cel can change of each condition is offered. The approach containing the step which forms in said crossover field the magnetic memory cell by which said variability MAG field is asymmetrically formed substantially magnetically in the surroundings of the magnetic shaft.
[Claim 11] The approach according to claim 10 which said variability MAG field of said magnetic memory cell equips the corner with the include angle of a non-right angle, and is formed so that it may be fabricated as a plane parallelogram substantially [the surroundings of the magnetic shaft].
[Claim 12] The approach according to claim 10 by which said magnetic memory cell is formed in said crossover field so that the magnetic shaft may become parallel to one side of said 1st and 2nd crossover lead wire.
[Claim 13] The approach according to claim 10 formed so that said variability MAG field may be magnetically fabricated asymmetrically by the internal magnetic anisotropy around the magnetic shaft.
[Claim 14] The approach according to claim 10 of containing further the step which prepares the magnetic-bias field nearest to [in order to bring an unsymmetrical configuration magnetically to the surroundings of said magnetic shaft, applying bias] said variability MAG field.
[Claim 15] It is substantially fabricated as a square which has the magnetic shaft with which alignment of said variability MAG field was carried out among the corners which the 1st square pair counters. Alignment of said bias is carried out along the corner where the 2nd pair of said square counters, and said bias maintains the common magnetization direction in all four corners of said square. By that cause The approach according to claim 14 by which the magnetic asymmetry of said variability MAG field is brought to the surroundings of said magnetic shaft, and two kinds of magnetization directions are imposed in the internal part of the variability field of said square.
[Claim 16] The step which prepares two or more 1st and 2nd crossover lead wire which forms two or more crossover fields which include said crossover field by that cause including said 1st and 2nd crossover lead wire, It is formed so that it may be asymmetrically fabricated substantially magnetically including said magnetic memory cell around the magnetic shaft with which each can impose two kinds of magnetization directions along with it so that two kinds from which each cel can change of each condition may be offered. The approach according to claim 10 of containing further the step which forms each of the MAG memory cell of plurality [one] respectively of said two or more crossover fields.
[Claim 17] Two kinds of magnetization directions in alignment with said magnetic shaft are the opposite approaches according to claim 10 mutually.
[Claim 18] The approach according to claim 10 by which said magnetic memory cell is formed from at least one magnetic tunnel junction.
[Claim 19] It is the magnetic memory cell which has the 1st and 2nd crossover lead wire which forms a crossover field, and the magnetic shaft which is arranged to said crossover field and can impose two kinds of magnetization directions along with it. By that cause According to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, two kinds from which said cel can change of each condition is offered. Magnetic memory containing the magnetic memory cell by which said cel has been arranged in said crossover field so that said magnetic shaft may be un-parallel to either of said 1st or 2nd crossover lead wire.
[Claim 20] The 1st and two or more 2nd crossover lead wire which form two or more crossover fields including said crossover field including said 1st and 2nd crossover lead wire, Each has the magnetic shaft of two or more of said crossover fields with which it is arranged one, respectively and each can impose two kinds of magnetization directions along with it including said magnetic memory cell. By that cause According to the magnetic stimulation impressed to it with said each 1st and 2nd crossover lead wire which forms each crossover field, two kinds from which each cel can change of each condition is offered. the magnetic shaft is un-parallel to either [the / each] the 1st or the 2nd [each] crossover

lead wire -- as -- each -- the magnetic memory according to claim 19 which contains further two or more magnetic memory cells by which each cel has been arranged in each of the crossover field.
[Claim 21] Magnetic memory according to claim 19 in which said magnetic shaft forms either of said 1st or 2nd crossover lead wire, and a larger include angle than about 5 times.
[Claim 22] The step which prepares the 1st and 2nd crossover lead wire which is an approach for creating magnetic memory and forms a crossover field by that cause, It is the step which positions a magnetic memory cell to said crossover field, and has the magnetic shaft with which said magnetic memory cell can impose two kinds of magnetization directions along with it. By that cause According to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, two kinds from which said cel can change of each condition is offered. The approach said cel contains the step positioned in said crossover field so that said magnetic shaft may be un-parallel to either of said 1st or 2nd crossover lead wire.
[Claim 23] The step which prepares two or more 1st and 2nd crossover lead wire which forms two or more crossover fields which include said crossover field by that cause including said 1st and 2nd crossover lead wire, It is the step which positions each of two or more magnetic memory cells of two or more of said crossover fields to one including said magnetic memory cell, respectively. It has the magnetic shaft with which each magnetic memory cell can impose two kinds of magnetization directions along with it. By that cause According to the magnetic stimulation impressed to it with said each 1st and 2nd crossover lead wire which forms each crossover field, two kinds from which each cel can change of each condition is offered. the magnetic shaft is un-parallel to either [the / each] the 1st or the 2nd [each] crossover lead wire -- as -- each -- the approach according to claim 22 each cel contains further the step positioned in each of the crossover field.
[Claim 24] The approach according to claim 22 by which said magnetic memory cell is positioned so that the magnetic shaft may form either of said 1st or 2nd crossover lead wire, and a larger include angle than about 5 times.
[Claim 25] It has in it a magnetic memory cell including the variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it. By that cause In the magnetic memory which offers two kinds from which said cel can change of each condition according to the magnetic stimulation impressed to it How to be an approach for changing said variability MAG field among said two kinds of magnetization directions, and contain the step which impresses said magnetic stimulation towards being un-parallel to said variability field to said shaft.
[Claim 26] An approach including said impression step using the line arranged to said magnetic shaft so that consequent magnetic stimulation may be impressed towards being un-parallel to said variability field to said magnetic shaft according to claim 25.
[Claim 27] The approach according to claim 26 by which said line and said variability MAG field are arranged so that said magnetic shaft may not become perpendicular to said line.
[Claim 28] The approach according to claim 27 by which said line and said variability MAG field are arranged so that only an include angle with said magnetic larger shaft than about 5 times may not become perpendicular to said line.
[Claim 29] The approach according to claim 25 of said impression step using the 1st and 2nd magnetic stimulation from each 1st and 2nd lines which cross most near said cel, and including that said direction of said magnetic stimulation is attained according to each scale of said 1st and 2nd magnetic stimulation, timing, or its both.
[Claim 30] Using said 1st and 2nd magnetic stimulation contains the rate that the mediation value of said 2nd magnetic stimulation is fixed of each mediation value of said 1st magnetic stimulation. By that cause The approach according to claim 29 of including carrying out the sweep of the magnetic stimulation of said 1st and 2nd both at coincidence in each 2nd value from each 1st value so that said magnetic stimulation may be impressed in said direction of being un-parallel to said magnetic stimulation as a result.
[Claim 31] The approach according to claim 30 said fixed percentage is about 10% so that said direction of being un-parallel may become about 5 times to said magnetic shaft.

[Claim 32] The approach according to claim 30 said 1st and 2nd lines cross perpendicularly mutually most near said cel so that said 1st and 2nd magnetic stimulation may be impressed perpendicularly mutually and one side of said line may become parallel to said magnetic shaft.
[Claim 33] It has in it a magnetic memory cell including the variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it. By that cause In the magnetic memory which offers two kinds from which said cel can change of each condition according to the magnetic stimulation impressed to it It is an approach for changing said variability MAG field among said two kinds of magnetization directions. Are the step which impresses said magnetic stimulation to said variability field, and the 1st and 2nd magnetic stimulation from each 1st and 2nd lines which cross most near said cel is used. The approach containing a step including said direction of said magnetic stimulation being attained according to each scale of said 1st and 2nd magnetic stimulation, timing, or its both.
[Claim 34] An approach including using said 1st and 2nd magnetic stimulation carrying out the sweep of said 1st magnetic stimulation to the 2nd value from the 1st value, holding said 2nd magnetic stimulation to constant value according to claim 33.
[Claim 35] The approach according to claim 34 said 1st and 2nd lines cross perpendicularly mutually most near said cel so that said 1st and 2nd magnetic stimulation may be impressed perpendicularly mutually and one side of said line may become parallel to said magnetic shaft.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the creation and access of a magnetic memory cell in magnetic random access memory ("MRAM").
[0002]
[Description of the Prior Art] It is indicated by U.S. Pat. No. 5,640,343 of two affairs, and No. 5,650,958, and the magnetic-random-access-memory ("MRAM") array of the type shown in drawing 1 R> 1 and drawing 2 of this application contains the array of the magnetic memory cell (for example, cel 9) positioned at the intersection of word lines 1, 2, and 3 and bit lines 4, 5, and 6. Each cel includes variability, or "freedom" field 24 and the nearest magnetic criteria field 20 in the magnetic target stationed so that it may become the magnetic tunnel junction ("MTJ") device 8. The principles used as the foundation of storing of the data in such a cel are the relative orientation of magnetization of freedom and a criteria field being changed, and being able to read the difference of this relative orientation after that by changing the magnetization direction in accordance with the easy axis ("EA") of a free field. (Vocabulary called a criteria field is used in large semantics here so that what type which changes a device into a detectable condition as a whole of field may also be shown in cooperation with freedom or a variability field.)
[0003] When a MRAM cel reverses magnetization of a free field using the bidirectional electrical stimulation impressed through each bit line and word line, and the magnetic stimulation of the result, writing is more specifically performed. Then, by measuring the consequent tunnel resistance between a bit line and a word line, read is performed and this takes one side of two values decided by relative orientation of the magnetization of a free field to a criteria field. a criteria field although it can rotate freely, when the free field is modeled as a simple simple substance magnet which has the magnetization direction where the inclination which meets the easy axis, shifts and aligns in that direction (+EA or -EA) is strong -- for example Although it is the same element magnet, when it has the magnetization direction fixed in the +EA direction, about the cel, two kinds of conditions (therefore, two kinds of possible tunnel resistance) of alignment (+EA/+EA) and reverse alignment (-EA/+EA) are defined.
[0004] The ideal hysteresis loop which shows the property of the tunnel junction resistance to impressed EA field is shown in drawing 3 . Resistance of a tunnel junction is in the condition that no stimulus is added in the field 50, namely, the sensibility of the resistance to the field to which below easy-axis flip magnetic-field-strength +/-Hc in a field 50 was impressed is missing, and can present one side of two separate values. When the impressed easy-axis field exceeds +/-Hc, the cel will be in each high resistance condition or a low resistance condition compulsorily.
[0005] if the magnetization direction of a free field is reversed during writing even if the magnetization pattern of two fields which form a tunnel junction is simple -- actual -- while -- or it may have unexpected effect on both fields. For example, if a free field is reversed during writing, magnetic **** or the compound domain wall fixed by a defect or edge coarseness may be included. Since a bond resistance is decided by dot product mfreemreference equalized about the junction field, if such

compound minute magnetism structure is included in a magnetization pattern, the tunnel junction resistance measured in read may be collapsed substantially.

[0006] For example, although the magnetization pattern in the free MAG field 124 of the MRAM cel formed in the surroundings of the easy axis EA at bilateral symmetry is shown in drawing 4 , in the field, it is in the condition that the complicated box-frame construction 132 is in sight clearly among the magnetization pattern spaces 130 and 134 originally accepted. This whole magnetization pattern is obtained from the sample magnetized by title top homogeneity (both up-and-down layers are pointing to **** from the first), and the sweep of the easy-axis bias about it is carried out from +700Oe to -700Oe, and it is returned to +700Oe. The sweep of the magnetic reversal which developed into the structure 132 complicated as a field was carried out from +700Oe to abbreviation-600Oe. Drawing 5 is the hysteresis loop which shows the relative magnetization direction over the easy-axis field by which it was impressed for [this] collapse samples. Although a cel stops presenting either of two kinds of the condition as expected since a field 150 is not a square when an easy-axis impression field is removed, this is because such compound minute magnetism structure progressed within the cel.

[0007] According to such magnetic structure that is not desirable, in the best case, an operational-parameter aperture is reduced, or when the worst, the hysteresis loop of a square required for storage collapses completely. Furthermore, such existence of structure can expect that a free field causes increase of the size of reversal or a change line required in order to be substantially reversed, power, or its both.

[0008]

[Problem(s) to be Solved by the Invention] Therefore, in case a required thing changes the condition of the magnetic memory cell in a MRAM array, it is the technique for removing such compound minute magnetism structure.

[0009]

[Means for Solving the Problem] In order to conquer the fault of the above-mentioned magnetic memory cell, one mode of this invention is related with the magnetic memory which has the 1st and 2nd crossover lead wire which forms a crossover field. A magnetic memory cell is positioned to a crossover field, and, thereby, offers two kinds from which a cel can change of each condition including the variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it. This cel can change to two kinds of each condition according to the magnetic stimulation impressed to it with the 1st and 2nd crossover lead wire. A magnetization pattern can develop appropriately during writing, without forming a variability MAG field so that it may be asymmetrically fabricated substantially magnetically around the magnetic shaft, therefore forming the above-mentioned compound minute magnetism structure.

[0010] The variability MAG field of a cel can equip the corner with the include angle of a non-right angle, and can fabricate it as a plane parallelogram substantially [the surroundings of the magnetic shaft]. or -- or combining it, the probably nearest bias field can be used for a variability MAG field, and it can fabricate it asymmetrically magnetically around the magnetic shaft by the internal magnetic anisotropy.

[0011] In other modes, this invention relates to the magnetic memory which has the 1st and 2nd crossover lead wire which forms a crossover field. As mentioned above, a magnetic memory cell is positioned to a crossover field, has the magnetic shaft which can impose two kinds of magnetization directions along with it, and, thereby, offers two kinds from which a cel can change of each condition according to the magnetic stimulation impressed to it with the 1st and 2nd crossover lead wire. This cel is positioned in a crossover field so that that magnetic shaft may be un-parallel to either of the 1st or 2nd crossover lead wire. With 1 operation gestalt, a magnetic shaft forms a larger include angle than about 5 times to either of the 1st or 2nd crossover lead wire.

[0012] In addition to the above-mentioned technique for imposing intentional asymmetry on the surroundings of the magnetic shaft of a memory cell physically, this invention relates also to arranging the magnetic stimulation impressed to the cel from the 1st and 2nd lead wire so that magnetic stimulation might be asymmetrically impressed to it according to the relative scale of the field impressed

with each lead wire of each, timing, or its both.
[0013] With 1 operation gestalt, while a bias field is impressed using a word line and the bias value is impressed, the sweep of the bit line is carried out to a high value from a low value. With other operation gestalten, although the sweep of both lines is carried out to each high value from each low value at coincidence, scales differ, for example, a word line becomes 10% of the value of a bit line. Thus, as for the impressed stimulus asymmetry, the magnetization pattern also shows progressing appropriately during writing.
[0014] If the above-mentioned technique, i.e., physical asymmetry, stimulus asymmetry, or its both are used, it can be expected that the magnetization pattern in the free field of a magnetic memory cell is reversed in other condition from the condition of being without forming the compound minute magnetism structure which is not desirable. Since the tunnel resistance of a cel will present one side of two values as prediction when it removes the impressed write-in field, the overall performance of a cel is improved.
[0015]
[Embodiment of the Invention] The technique for conquering the above-mentioned problem relevant to the flux reversal in a MRAM cel is indicated here. This technique improves a flux reversal process substantially including a write-in stimulus of a MRAM cel, physical design, or the internal asymmetry of those both. Various ways including an unsymmetrical MAG write-in stimulus (for example, thing impressed at an angle of predetermined to the easy axis using the easy-axis field and hard shaft field by which are "an axial blank" or the sweep was carried out to coincidence using the fixed hard shaft field impressed with the easy-axis field by which the sweep was carried out) can attain this asymmetry. Moreover, the physical junction asymmetry which uses the non-alignment of a cel with the thin film configuration asymmetry, the bit line of relation, or word line which carried out pattern formation, or the internal anisotropy in the junction field which fractures a junction configuration or magnetization symmetric property around the shaft is also indicated.
[0016] The principle of this invention about internal asymmetry is described below in relation to drawing 7 thru/or drawing 17 . However, the general principle which serves as a foundation of the formation of a magnetic memory array first shown in drawing 1 - drawing 2 and actuation by U.S. Pat. No. 5640343 and No. 5650958 as a background is explained briefly.
[0017] When drawing 1 is referred to, the example of a MRAM array contains 1 set of electric conduction lines which function as parallel word lines 1, 2, and 3 within a level flat surface, and 1 set of electric conduction lines which function as parallel bit lines 4, 5, and 6 within other level flat surfaces. When it sees from a top, the bit line is turned to the right angle to the word line in the different direction so that 2 sets of lines may cross. Memory cells, such as the typical memory cell 9 shown in a detail at drawing 2 , are located in each crossing of the word line in the crossover field in which spacing was opened perpendicularly among lines, and a bit line. Although three word lines and three bit lines are shown in drawing 1 , the number of lines will usually increase more than this considerably. A memory cell 9 is arranged as a perpendicular stack, and can contain diode 7 and the magnetic tunnel junction ("MTJ") 8. Working [of an array] and a current flow the inside of a cel 9 perpendicularly. When a current passes along a memory cell perpendicularly, surface area which a memory cell occupies can be made very small. Each contact with a contact with a word line, MTJ, diode, and a bit line occupies the same area. Although not shown in drawing 1 , this array can be formed on substrates, such as a silicon substrate in which other circuits should exist. Moreover, in the field of MRAM(s) other than a tolerance field, the layer of an insulating material is usually located between a bit line and a word line.
[0018] The structure of a memory cell 9 is explained to a detail with reference to drawing 2 . The memory cell 9 is contacted and formed in the word line 3 (drawing 1) top and the word line. A memory cell 9 contains the perpendicular stack 7, for example, the silicon junction diode which is the series connection electrically, and MTJ8 of a diode-like device. Diode 7 is the silicon junction diode containing n mold silicon layer 10 and the p-type silicon layer 11. The p-type silicon layer 11 of diode is connected to MTJ8 through the tungsten stud 12. n mold silicon layer 10 of diode is connected to the word line 3.

[0019] MTJ8 can be formed in a series of ingredient layers accumulated by turns. MTJ8 of drawing 2 The template layers 15, such as Pt, and the initial ferromagnetism layers 16, such as a permalloy (nickel-Fe), Regularity of antiferromagnetism layers (AF), such as Mn-Fe,18, Co, Fe, a permalloy, etc., or the criteria ferromagnetism layer 20 of a "fixed" mold (FMF), The thin tunnel barrier layer 22 of an alumina (aluminum 2O3), the soft variability "freedom" ferromagnetism layers (FMS) 24, such as sandwiches of a thin Co-Fe and a thin permalloy, and the contact layers 25, such as Pt, are included.
[0020] The free layer is created so that it may have a desirable shaft for the magnetization direction of an easy axis ("EA"). The direction of two kinds is possible as a magnetization direction of the free layer in alignment with this easy axis, and this defines two kinds of conditions of a memory cell. By contrast, a typical floor can be created so that it may have only the one desirable magnetization direction of that direction of a unidirectional anisotropy, and this direction is parallel to the easy axis of a free layer. The easy axis of a request of a free layer is set up with the combination of the proper anisotropy of MTJ, strain induced anisotropy, and shape anisotropy. Width of face can create [die length] MTJ and the free layer of illustration as a rectangle of W by L, and L is larger than W (drawing 2). The magnetic moment of a free layer tends to align along the direction of L.
[0021] The direction of a unidirectional anisotropy of a typical floor is Fe-Mn on the initial ferromagnetism layer 16. It is set up by growing up the AF layer 18, and the initial ferromagnetism layer itself grows on the template layers 15, such as Pt, or Cu or Ta. The template layer 15 guides the crystallographic texture of 111 in the initial ferromagnetism layer 16. It adheres to these layers in the field turned in parallel with the easy axis of a request of a free layer, and they create the direction of a proper unidirectional anisotropy of a request of a typical floor. Or AF layer can also adhere on the template layer within the field of sufficient magnitude parallel to said easy axis, while heating the substrate to temperature higher than the blocking-proof temperature of AF ingredient. In this alternative example, the initial ferromagnetism layer 16 is unnecessary. Moreover, in order to make it generate while processing the magnetic anisotropy which aligns magnetization along the direction of an impression field under adhesion, it is also possible to use the magnetostriction of a fixed layer.
[0022] Since it is switched connection between the typical floor and AF layer, changing from the magnetization direction of a free layer is difficult for the magnetization direction of a typical floor. or [that the magnetization direction of a typical floor becomes fixed in this example within the limits of the field impressed according to the current which passes along a bit line and a word line] -- or it is fixed. The shape anisotropy of a typical floor adds the stability of the magnetization direction of a fixed layer according to the shape anisotropy of MTJ. The field impressed in order to write in a memory cell is sufficient magnitude to reverse not the direction of a typical floor but the magnetization direction of a free layer. Therefore, even if it magnetizes a fixed layer, a direction is not changed working [the memory cell in MRAM].
[0023] The self-field of the current combined on the intersection of a writing ray and a bit line when the current of magnitude sufficient during array actuation passed both the writing rays and bit lines of MRAM makes magnetization of the free layer of single specific MTJ located in the intersection of the excited writing ray and a bit line rotated. Current level is designed so that the combined self-field may exceed the switching field of a free layer. This self-field is designed so that it may become quite smaller than a field required in order to rotate magnetization of a typical floor. Cel array architecture is designed so that a write-in current may not pass the MTJ itself. A memory cell is read by passing a sense current from a typical floor perpendicularly to a free layer (or the reverse) through the tunnel junction barrier through diode and MTJ. Since resistance of the aluminum2O3 tunnel barrier is remarkably dependent on the thickness of 2O3 layers of aluminum and it changes almost exponentially according to the thickness of this layer, this means that a current mainly flows perpendicularly through the aluminum2O3 tunnel barrier. Since the probability for a charge carrier to pass through the barrier falls remarkably as the thickness of aluminum 2O3 is increased, the only support which passes through a joint moves perpendicularly to a junctional zone. The condition of a memory cell is decided by measuring resistance of a memory cell, when a sense current quite smaller than a write-in current passes MTJ perpendicularly. Since the self-fields of this sense current or a read current are very few, the magnetic condition of a

memory cell is not influenced. It depends on relative alignment of the magnetic moment of a free layer and a typical floor for the probability for a charge carrier to pass through the tunnel barrier. Spin polarization of the tunnel current is carried out, and it means that one of the ferromagnetic layers, for example, the current transmitted from a fixed layer, mainly consists of one spin type (it responds to the orientation of magnetization of a ferromagnetic layer, and they are a spin up or a spin down) electrons. Extent of the spin polarization of a current is decided by electronic band structure of the magnetic material which constitutes the ferromagnetic layer in the interface of a ferromagnetic layer and the tunnel barrier. Therefore, the 1st ferromagnetic layer tunnel barrier operates as a spin filter. It depends for the probability for a charge carrier to pass on whether the electronic state of the same spin polarization as the spin polarization of the current in the 2nd ferromagnetic layer is acquired. Usually, if the magnetic moment of the 2nd ferromagnetic layer aligns at the magnetic moment of the 1st ferromagnetic layer, many electronic states will be acquired from the time of the magnetic moment of the 2nd ferromagnetic layer reverse-aligning at the magnetic moment of the 1st ferromagnetic layer. Therefore, the tunnel probability of electrification support becomes the highest when the magnetic moment of both layers aligns, and when the magnetic moment reverse-aligns, it becomes the minimum. It is not alignment or reverse alignment, either, and when the moment has been arranged, a tunnel probability takes a mean value. Therefore, it depends for the electric resistance of a cel on both the spin polarization of the current of both ferromagnetic layers, and an electronic state. Consequently, two kinds of bit conditions (0 or 1) of a memory cell are clearly defined by two kinds of magnetization directions of a free layer.

[0024] This invention examines first one unsymmetrical format, i.e., stimulus "axial blank" magnetic bias, here. The result of the unsymmetrical experiment and the simulation which were realized using the easy-axis field which carried out the sweep with the fixed perpendicular hard shaft field is shown about this point in relation to drawing 6 , drawing 7 , drawing 9 R> 9, drawing 10 , and drawing 11 . Drawing 6 is the top view of the symmetry junction configuration used in order to verify this technique. If the timing chart of drawing 7 is referred to, the sweep of the easy-axis field value 210 will be carried out to a forward value (****) from a neutral value along an inclination 215 by this invention, and, thereby, it will rotate magnetization by it. The hard shaft field 220 is held in this trace interval at constant value 225. Therefore, in order to write in the condition of rotating magnetization, consequently being in a cel, asymmetry "axial blank" magnetic bias is supplied.

[0025] Drawing 9 is the array of the hysteresis loop measured about 14 joints fabricated similarly about each value of the fixed hard shaft bias Hh of 0-+/-50Oe. Each cel is a 2.7micrometerx1.2micrometer hexagon (for example, drawing 6), and the easy axis is arranged in parallel to the long edge. The impressed easy-axis field (helium) is inadequate in order to reverse the criteria field which is downward, the forward easy-axis field carried out opposition doubling of a free field and the criteria field, consequently resistance became higher (MR%).

[0026] In hardware shaft bias Hh=0Oe-+/-10Oe, a serious problem including lack of the similarity of the loop formation of various cels or lack (358 356) of the loop-formation field which can be checked is discriminable. In hardware shaft bias Hh=+/-20Oe, a remarkable improvement can be observed, and when it is this hard shaft bias, the appropriate loop-formation field 354 can be identified. Although more smoother fixed configuration loop formations will be acquired if hard shaft bias is increased further, squareness and a loop-formation field fall victim (350 352).

[0027] In addition to such measurement, originally to the stimulus asymmetry which uses the fixed hard shaft bias of drawing 7 , the response of a symmetrical joint was also simulated. About the hard shaft bias of 20Oe(s) and 70Oe(s), each shows this simulation result about 1x0.5-micrometer sample of a permalloy layer with a thickness of 70A to drawing 10 and drawing 11 , respectively. Although box-frame construction developed when the minute magnetism structure of each case was inspected, and there was no external bias, in the case of the bias of 20 or more Oes, it became clear that rotation of the magnetization generated when a bias field is reversed becomes the anti-symmetry, and do not generate harmful minute magnetism structure, therefore the smooth hysteresis loop is formed.

[0028] Moreover, the stimulus asymmetry of this invention is realizable working by using both an easy

axis with which the sum total field which increases to homogeneity as a result is impressed at an angle of predetermined to an easy axis and which carried out the sweep, and a hard shaft field. This technique is 235 by which the sweep of the easy-axis field 230 is carried out to the 2nd value by the principle of this invention from the 1st value in this drawing although shown in drawing 8 . As for the range of a value, 245 by which a sweep is carried out similarly in this spacing is [the hard shaft field 240] more low, for example, it has become 10% of an easy-axis value. The consequent include angle of field impression must be enough so that sufficient hard shaft field component to guarantee unsymmetrical development of the pattern at the time of the magnetic field strength with which the symmetry of magnetization is established clearly may exist. In the case of the cel examined so far, this invention person found that the axial blank include angle of 5 - 10 degrees was appropriate. the difference of 10% of scale shown in drawing 8 -- consequent -- an easy axis -- receiving -- ** (0.1/1.0) -- it becomes the include angle of the arc tangent to say, or about 5.7 degrees.
[0029] If it is this contractor, the stimulus asymmetry of other formats depending on a junction configuration etc. will also be known. Generally, the stimulus asymmetry of this invention includes that development of the magnetization pattern which can be predicted within a cel is caused by predetermined fluctuation of the scale of the impressed easy axis and a hard shaft field, timing, or its both.
[0030] In addition to fluctuation of the scale of the format of the above-mentioned stimulus asymmetry, i.e., the impressed easy axis, and a hard shaft field, timing, or its both, asymmetry can also be physically designed in a joint. In this technique, it is necessary to design a junction property so that the physical configuration of a certain format, magnetic asymmetry, or its both may be taken in in it.
[0031] The surrounding asymmetrical cell design of the easy axis EA which is distorted so that the cel configuration itself may become a parallelogram, and has the corner of a non-right angle by the principle of this invention as moreover shown in the top view of the joint of drawing 12 is realizable. When there are not a case where the sweep of the easy-axis field is carried out, and a hard shaft bias field, according to the simulation performed about this type of structure, the inclination which the unsymmetrical magnetization which is in agreement with a device configuration generates is strong, therefore it turns out that the clear corresponding hysteresis loop is acquired.
[0032] Other techniques for imposing asymmetry on cell layout are shown in drawing 13 . As mentioned above, a magnetic memory cell is usually arranged at the intersection of word lines 701, 702, and 703 and bit lines 704, 705, and 706. A cel 709 is arranged at the intersection of a word line 701 and a bit line 706, and it is positioned by the predetermined include angle to the field impressed by the bit line so that the reversible field to which the (the long and slender configuration was met) easy axis was impressed from the bit line 706, and a predetermined include angle (for example, 5 - 10 degrees) may be formed. Therefore, to a bit line 706, this cel offers the reversible MAG write-in field of about 5 - 10 degrees rather than is [for example,] perpendicular.
[0033] Although an internal magnetic anisotropy can be imposed in a symmetrical joint and the asymmetry of the above-mentioned type and magnetic asymmetry same type are brought about in other techniques for imposing the physical asymmetry of this invention originally which fractures the magnetic junction symmetry, it is not necessary to distort the actual layout of a cel.
[0034] Or magnetic bias can be taken in in order to fracture the magnetic symmetry.
[0035] For example, if drawing 14 thru/or drawing 15 are referred to, the cel 809 originally symmetrically fabricated around the easy axis can have the internal magnetic bias 850 imposed on it, in order to maintain the magnetization direction desirable in the corner. This bias can be made into the thing in alignment with a perpendicular hard shaft.
[0036] If the sectional view of drawing 15 is referred to, by the conductive layer 825 of arbitration, the variability field 824, the tunnel layer 822, and the bias layer 826 separated from the criteria field 820 can be used, and this internal magnetic bias can be offered.
[0037] although two kinds which still met the easy axis (EA) of each magnetization direction can be imposed at the include angle of an easy axis to about 45 degrees although it is not the opposite -- if drawing 16 thru/or drawing 17 are referred to, magnetic bias 850 fixes the corner 860 of a square cel,

and, thereby, promotes reversal of the magnetization direction in a cel. Bias 850 brings magnetic asymmetry to the surroundings of an easy axis, and this asymmetry promotes direction reversal without the harmful minute magnetism structure which forms a cel.
[0038] Although the symmetric property of a configuration is maintained, the consistency of the cel in an array does not receive a bad influence by imposing magnetic asymmetry.
[0039] if the same technique as using it in order to form the cel indicated by said United States patent is used, cell layout will be distorted or a magnetic anisotropy will be incorporated at the suitable step under processing -- it is -- it is -- an unsymmetrical cel can be formed physically [this invention] by the both. This invention relates also to creation of an unsymmetrical cel physically [the above-mentioned] about this point.
[0040] If it is this contractor, it will turn out also in combination like the above-mentioned stimulus unsymmetrical technique and a physical unsymmetrical technique throat that it can be used in order to guarantee development of a suitable magnetization pattern.
[0041] The example of the unsymmetrical advantage offered by this invention is clear if drawing 18 and drawing 19 are examined. When starting the hysteresis loop from a full magnetization condition, the energy of one symmetry condition usually observed and two asymmetry simple conditions was calculated. Energy count of a symmetry joint is shown in drawing 18 , and it has the unsymmetrical conditions 1001 and 1002 and the symmetry condition 1003. The energy including the unsymmetrical conditions 2001 and 2002 and the symmetrical condition 2003 of an unsymmetrical joint is shown in drawing 19 . Graphical representation of the energy of these conditions is carried out as a thing to the impression field include angle (frequency unit) from an easy axis. When impression bias is zero, the energy of all three conditions has separated the unsymmetrical junction energy level of drawing 19 clearly, and it is shown that especially one unsymmetrical condition 2002 has been conditions advantageous to changing. By contrast, in symmetry junction of drawing 18 , when impression bias is zero, the ambiguity about the minute magnetism condition that there is no difference in an energy level about all of three kinds of possible conditions of a joint, consequently it can develop now occurs. Therefore, when a junction configuration is changed asymmetrically, it turns out that development of the magnetization pattern which can be predicted is promoted.
[0042] As a conclusion, the following matters are indicated about the configuration of this invention.
[0043] It is a magnetic memory cell including the variability MAG field equipped with the 1st and 2nd crossover lead wire which forms a crossover field, and the magnetic shaft which is arranged to said crossover field and can impose two kinds of magnetic directions along with it. (1) By that cause Magnetic memory which offers two kinds from which said cel can change of each condition according to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, and contains the magnetic memory cell by which said variability MAG field is asymmetrically fabricated substantially magnetically around the magnetic shaft.
(2) Magnetic memory given in the above (1) by which said variability MAG field of said magnetic memory cell equips the corner with the include angle of a non-right angle, and is fabricated as a plane parallelogram substantially [the surroundings of the magnetic shaft].
(3) Magnetic memory given in the above (1) by which said magnetic memory cell is arranged in said crossover field so that the magnetic shaft may become parallel to one side of said 1st and 2nd crossover lead wire.
(4) Magnetic memory given in the above (1) by which said variability MAG field is magnetically fabricated asymmetrically by the internal magnetic anisotropy around the magnetic shaft.
(5) Magnetic memory given in the above (1) which includes further the magnetic-bias field nearest to [in order to bring an unsymmetrical configuration magnetically to the surroundings of said magnetic shaft, applying bias] said variability MAG field.
(6) It is substantially fabricated as a square which has the magnetic shaft with which alignment of said variability MAG field was carried out among the corners which the 1st square pair counters. Alignment of said bias is carried out along the corner where the 2nd pair of said square counters, and said bias maintains the common magnetization direction in all four corners of said square. By that cause Magnetic

memory given in the above (5) on which the magnetic asymmetry of said variability MAG field is brought to the surroundings of said magnetic shaft, and two kinds of magnetization directions are imposed in the internal part of the variability field of said square.
(7) The 1st and two or more 2nd crossover lead wire which form two or more crossover fields including said crossover field including said 1st and 2nd crossover lead wire, Each is arranged at one each of two or more of said crossover fields including said magnetic memory cell. Magnetic memory given in the above (1) which contains further two or more magnetic memory cells asymmetrically fabricated substantially magnetically around the magnetic shaft with which each can impose two kinds of magnetization directions along with it so that two kinds from which each cel can change of each condition may be offered.
(8) Two kinds of magnetization directions in alignment with said magnetic shaft are magnetic memory given [opposite] in the above (1) mutually.
(9) Magnetic memory given in the above (1) in which said magnetic memory cell is formed from at least one magnetic tunnel junction.
(10) The step which prepares the 1st and 2nd crossover lead wire which is an approach for creating magnetic memory and forms a crossover field by that cause, The variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it is included. By that cause According to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, two kinds from which a cel can change of each condition is offered. The approach containing the step which forms in said crossover field the magnetic memory cell by which said variability MAG field is asymmetrically formed substantially magnetically in the surroundings of the magnetic shaft.
(11) An approach given in the above (10) which said variability MAG field of said magnetic memory cell equips the corner with the include angle of a non-right angle, and is formed so that it may be fabricated as a plane parallelogram substantially [the surroundings of the magnetic shaft].
(12) An approach given in the above (10) in which said magnetic memory cell is formed in said crossover field so that the magnetic shaft may become parallel to one side of said 1st and 2nd crossover lead wire.
(13) An approach given in the above (10) formed so that said variability MAG field may be magnetically fabricated asymmetrically by the internal magnetic anisotropy around the magnetic shaft.
(14) An approach given in the above (10) which contains further the step which prepares the magnetic-bias field nearest to [in order to bring an unsymmetrical configuration magnetically to the surroundings of said magnetic shaft, applying bias] said variability MAG field.
(15) It is substantially fabricated as a square which has the magnetic shaft with which alignment of said variability MAG field was carried out among the corners which the 1st square pair counters. Alignment of said bias is carried out along the corner where the 2nd pair of said square counters, and said bias maintains the common magnetization direction in all four corners of said square. By that cause An approach given in the above (14) on which the magnetic asymmetry of said variability MAG field is brought to the surroundings of said magnetic shaft, and two kinds of magnetization directions are imposed in the internal part of the variability field of said square.
(16) The step which prepares two or more 1st and 2nd crossover lead wire which forms two or more crossover fields which include said crossover field by that cause including said 1st and 2nd crossover lead wire, It is formed so that it may be asymmetrically fabricated substantially magnetically including said magnetic memory cell around the magnetic shaft with which each can impose two kinds of magnetization directions along with it so that two kinds from which each cel can change of each condition may be offered. An approach given in the above (10) which contains further the step which forms each of the MAG memory cell of plurality [one] respectively of said two or more crossover fields.
(17) Two kinds of magnetization directions in alignment with said magnetic shaft are approaches given [opposite] in the above (10) mutually.
(18) An approach given in the above (10) in which said magnetic memory cell is formed from at least one magnetic tunnel junction.

It is the magnetic memory cell which has the 1st and 2nd crossover lead wire which forms a crossover field, and the magnetic shaft which is arranged to said crossover field and can impose two kinds of magnetization directions along with it. (19) By that cause According to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, two kinds from which said cel can change of each condition is offered. Magnetic memory containing the magnetic memory cell by which said cel has been arranged in said crossover field so that said magnetic shaft may be un-parallel to either of said 1st or 2nd crossover lead wire.
(20) The 1st and two or more 2nd crossover lead wire which form two or more crossover fields including said crossover field including said 1st and 2nd crossover lead wire, Each has the magnetic shaft of two or more of said crossover fields with which it is arranged one, respectively and each can impose two kinds of magnetization directions along with it including said magnetic memory cell. By that cause According to the magnetic stimulation impressed to it with said each 1st and 2nd crossover lead wire which forms each crossover field, two kinds from which each cel can change of each condition is offered. the magnetic shaft is un-parallel to either [the / each] the 1st or the 2nd [each] crossover lead wire -- as -- each -- magnetic memory given in the above (19) which contains further two or more magnetic memory cells by which each cel has been arranged in each of the crossover field.
(21) Magnetic memory given in the above (19) said whose magnetic shaft forms either of said 1st or 2nd crossover lead wire, and a larger include angle than about 5 times.
(22) The step which prepares the 1st and 2nd crossover lead wire which is an approach for creating magnetic memory and forms a crossover field by that cause, It is the step which positions a magnetic memory cell to said crossover field, and has the magnetic shaft with which said magnetic memory cell can impose two kinds of magnetization directions along with it. By that cause According to the magnetic stimulation impressed to it with said 1st and 2nd crossover lead wire, two kinds from which said cel can change of each condition is offered. The approach said cel contains the step positioned in said crossover field so that said magnetic shaft may be un-parallel to either of said 1st or 2nd crossover lead wire.
(23) The step which prepares two or more 1st and 2nd crossover lead wire which forms two or more crossover fields which include said crossover field by that cause including said 1st and 2nd crossover lead wire, It is the step which positions each of two or more magnetic memory cells of two or more of said crossover fields to one including said magnetic memory cell, respectively. It has the magnetic shaft with which each magnetic memory cell can impose two kinds of magnetization directions along with it. By that cause According to the magnetic stimulation impressed to it with said each 1st and 2nd crossover lead wire which forms each crossover field, two kinds from which each cel can change of each condition is offered. the magnetic shaft is un-parallel to either [the / each] the 1st or the 2nd [each] crossover lead wire -- as -- each -- an approach given in the above (22) each cel of whose contains further the step positioned in each of the crossover field.
(24) An approach given in the above (22) by which said magnetic memory cell is positioned so that the magnetic shaft may form either of said 1st or 2nd crossover lead wire, and a larger include angle than about 5 times.
It has in it a magnetic memory cell including the variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it. (25) By that cause In the magnetic memory which offers two kinds from which said cel can change of each condition according to the magnetic stimulation impressed to it How to be an approach for changing said variability MAG field among said two kinds of magnetization directions, and contain the step which impresses said magnetic stimulation towards being un-parallel to said variability field to said shaft.
(26) An approach given in the above (25) including said impression step using the line arranged to said magnetic shaft so that consequent magnetic stimulation may be impressed towards being un-parallel to said variability field to said magnetic shaft.
(27) An approach given in the above (26) by which said line and said variability MAG field are arranged so that said magnetic shaft may not become perpendicular to said line.
(28) An approach given in the above (27) by which said line and said variability MAG field are arranged so that only an include angle with said magnetic larger shaft than about 5 times may not become

perpendicular to said line.
(29) An approach given in the above (25) which said impression step uses the 1st and 2nd magnetic stimulation from each 1st and 2nd lines which cross most near said cel, and includes that said direction of said magnetic stimulation is attained according to each scale of said 1st and 2nd magnetic stimulation, timing, or its both.
Using said 1st and 2nd magnetic stimulation contains the rate that the mediation value of said 2nd magnetic stimulation is fixed of each mediation value of said 1st magnetic stimulation. (30) By that cause An approach given in the above (29) which includes carrying out the sweep of the magnetic stimulation of said 1st and 2nd both at coincidence in each 2nd value from each 1st value so that said magnetic stimulation may be impressed in said direction of being un-parallel to said magnetic stimulation as a result.
(31) An approach given in the above (30) said whose fixed percentage is about 10% so that said direction of being un-parallel may become about 5 times to said magnetic shaft.
(32) An approach given in the above (30) which said 1st and 2nd lines intersect perpendicularly mutually most near said cel so that said 1st and 2nd magnetic stimulation may be impressed perpendicularly mutually and one side of said line may become parallel to said magnetic shaft.
It has in it a magnetic memory cell including the variability MAG field equipped with the magnetic shaft which can impose two kinds of magnetization directions along with it. (33) By that cause In the magnetic memory which offers two kinds from which said cel can change of each condition according to the magnetic stimulation impressed to it It is an approach for changing said variability MAG field among said two kinds of magnetization directions. Are the step which impresses said magnetic stimulation to said variability field, and the 1st and 2nd magnetic stimulation from each 1st and 2nd lines which cross most near said cel is used. The approach containing a step including said direction of said magnetic stimulation being attained according to each scale of said 1st and 2nd magnetic stimulation, timing, or its both.
(34) An approach given in the above (33) including using said 1st and 2nd magnetic stimulation carrying out the sweep of said 1st magnetic stimulation to the 2nd value from the 1st value, holding said 2nd magnetic stimulation to constant value.
(35) An approach given in the above (34) which said 1st and 2nd lines intersect perpendicularly mutually most near said cel so that said 1st and 2nd magnetic stimulation may be impressed perpendicularly mutually and one side of said line may become parallel to said magnetic shaft.

[Translation done.]

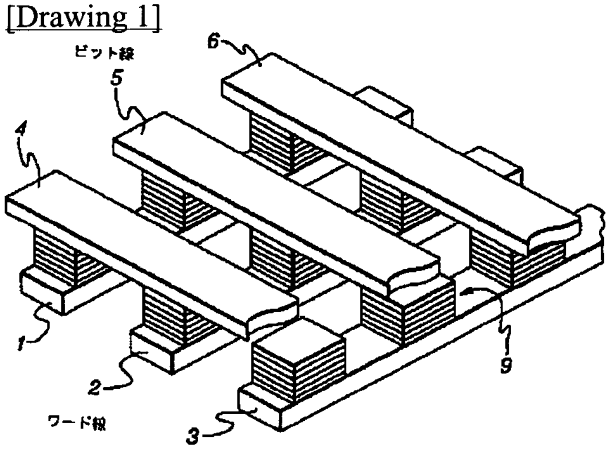
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

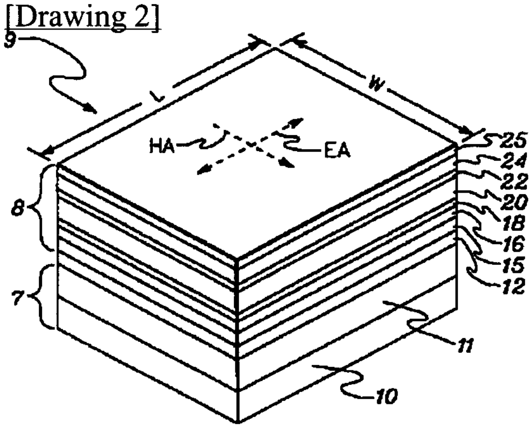
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

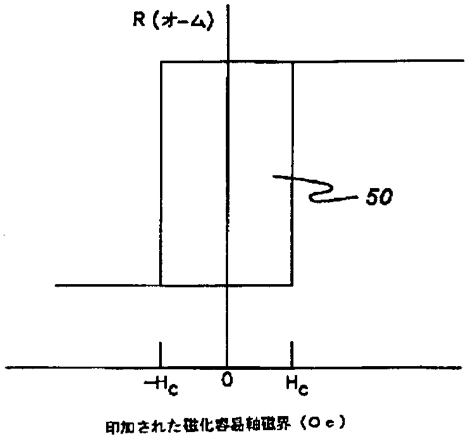
[Drawing 1]



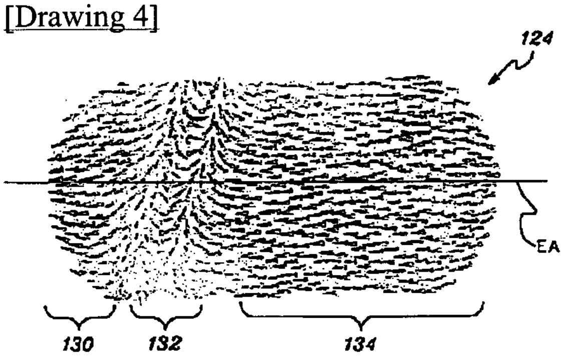
[Drawing 2]



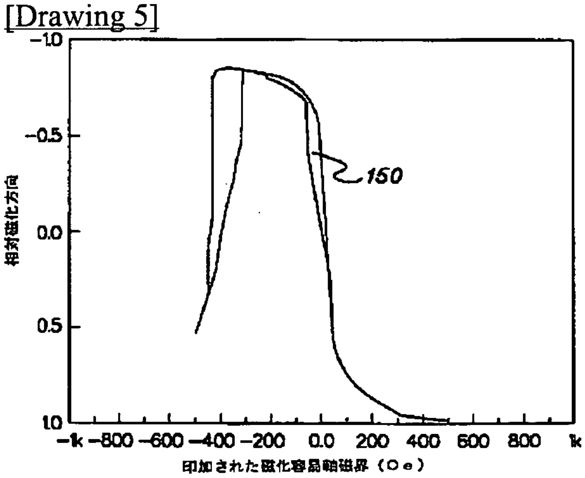
[Drawing 3]



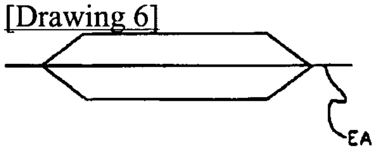
[Drawing 4]



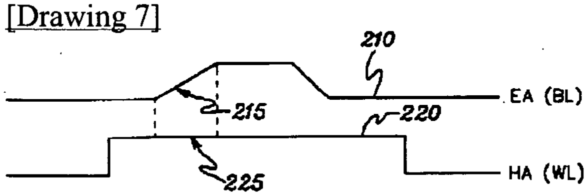
[Drawing 5]



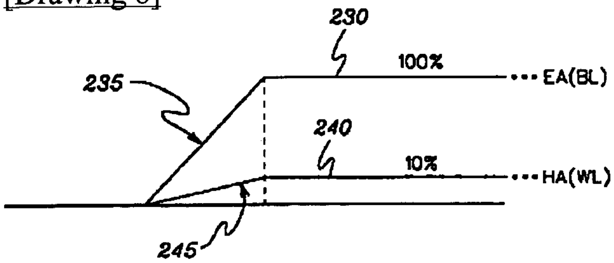
[Drawing 6]



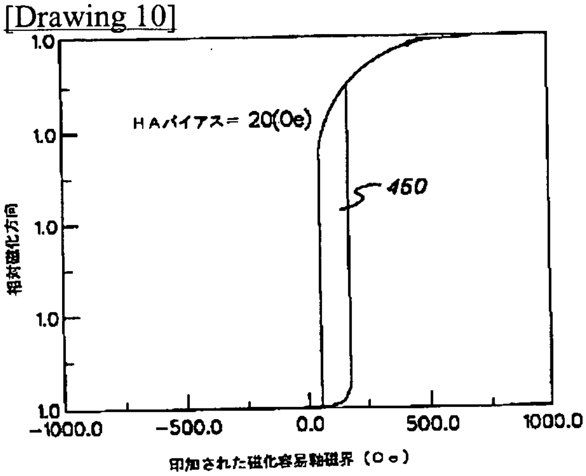
[Drawing 7]



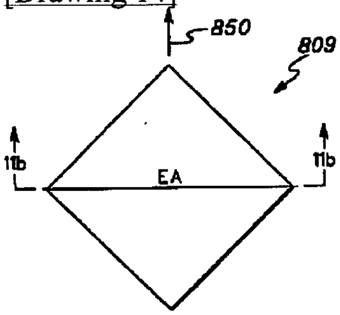
[Drawing 8]



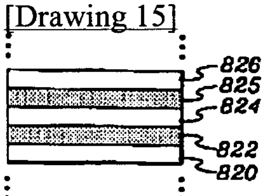
[Drawing 10]



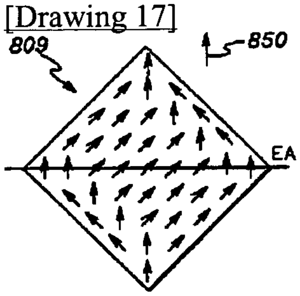
[Drawing 14]



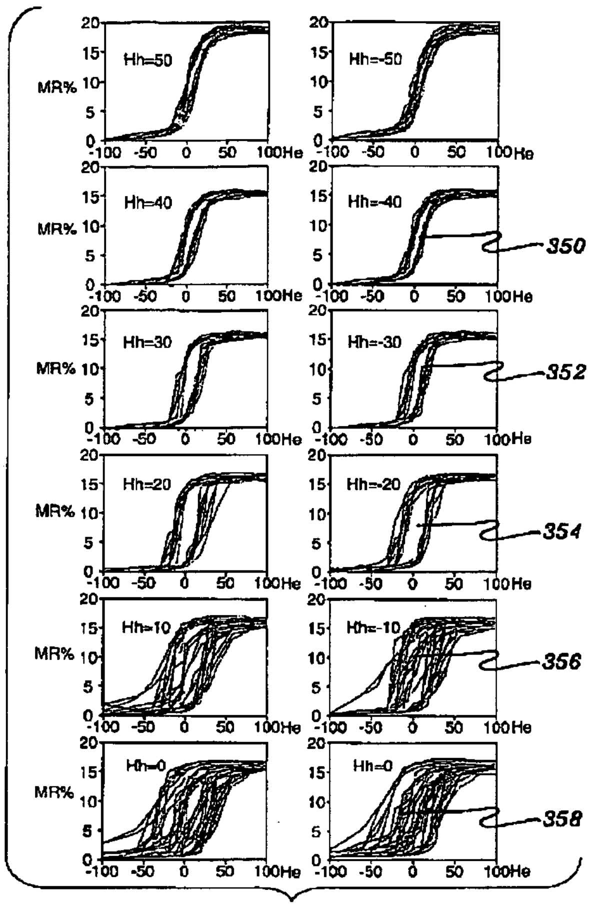
[Drawing 15]



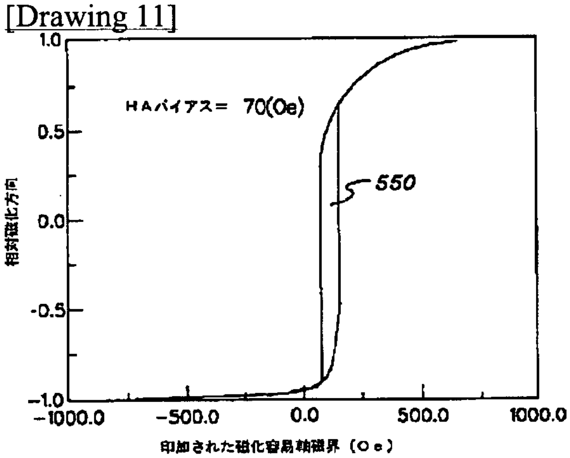
[Drawing 17]



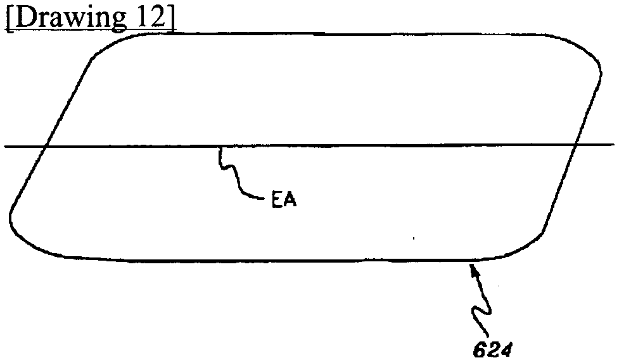
[Drawing 9]



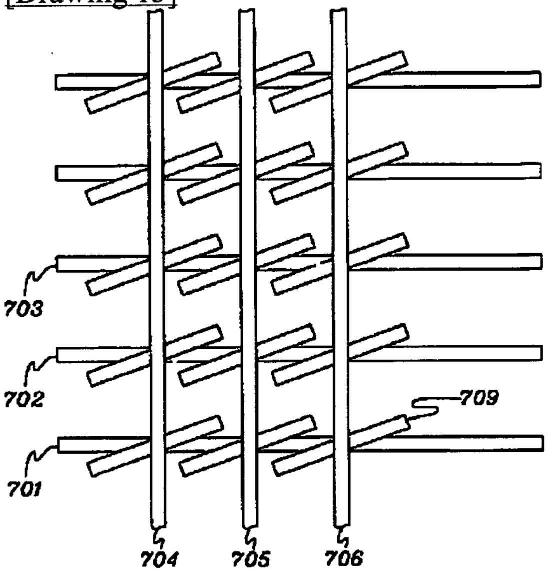
[Drawing 11]



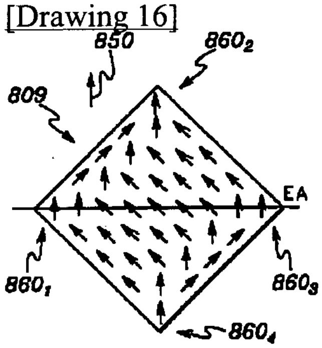
[Drawing 12]



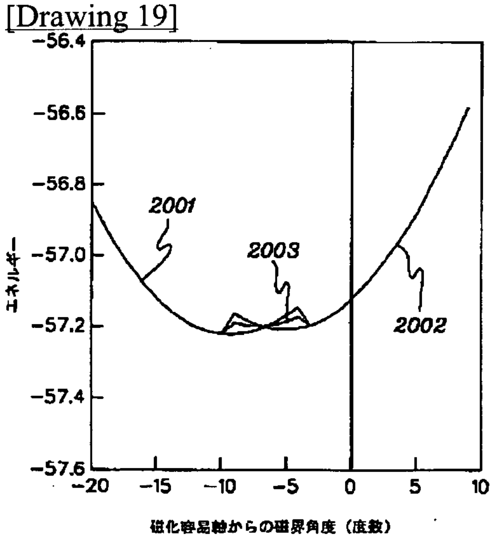
[Drawing 13]



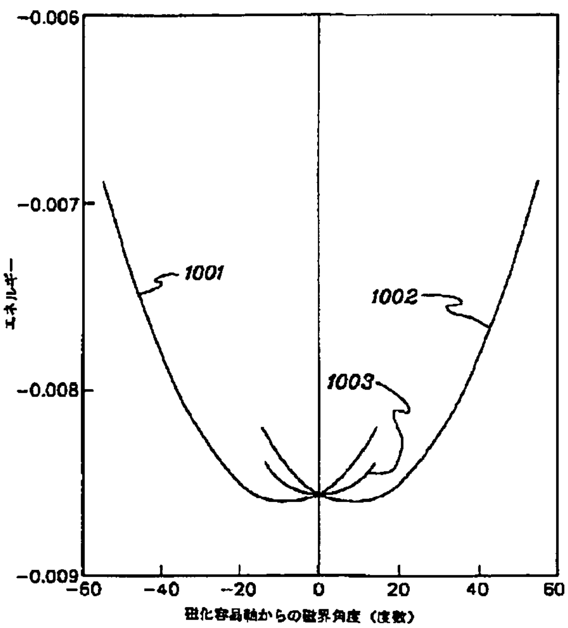
[Drawing 16]



[Drawing 19]



[Drawing 18]



[Translation done.]